Altitude Sickness

From HumanResearchWiki

Contents

Introduction

Hypoxia is a state of oxygen deficiency sufficient to cause impairment of function.[1] The underlying physiological process that leads to altitude sickness is an exaggerated vascular response to hypoxia. Altitude sickness incorporates several syndromes that vary in severity, ranging from acute mountain sickness (AMS), a relatively benign condition, manifesting as headaches, malaise, anorexia, nausea, vomiting, and trouble sleeping; to high-altitude pulmonary edema (HAPE), manifesting as shortness of breath progressing to incapacitating dyspnea and respiratory failure; high-altitude cerebral edema (HACE), manifesting as confusion, ataxia, hallucinations, and coma; and high-altitude retinal hemorrhage (HARH).[2]

Any decrease in ambient pressure without a concurrent and adequate increase in oxygen places the crew at risk for hypoxia and altitude sickness. There are several potential scenarios that could lead to an increase in effective spacecraft cabin altitude, thereby causing altitude sickness, including loss of cabin pressure during staged decompression prior to extravehicular activities (EVAs), a cabin leak, or a malfunction of the environmental control systems such that pressure is maintained but oxygen levels are reduced.[3][1] Treatment for altitude sickness involves increasing the atmospheric pressure and/or administering supplemental oxygen[1].

Clinical Priority and Clinical Priority Rationale by Design Reference Mission

One of the inherent properties of space flight is a limitation in available mass, power, and volume within the space craft. These limitations mandate prioritization of what medical equipment and consumables are manifested for the flight, and which medical conditions would be addressed. Therefore, clinical priorities have been assigned to describe which medical conditions will be allocated resources for diagnosis and treatment. "Shall" conditions are those for which diagnostic and treatment capability must be provided, due to a high likelihood of their occurrence and severe consequence if the condition were to occur and no treatment was available. "Should" conditions are those for which diagnostic and treatment capability should be provided if mass/power/volume limitations allow.

Conditions were designated as "Not Addressed" if no specific diagnostic and/or treatment capability are expected to be manifested, either due to a very low likelihood of occurrence or other limitations (for example, in medical training, hardware, or consumables) that would preclude treatment. Design Reference Missions (DRMs) are proposed future missions designated by a set of assumptions that encompass parameters such as destination, length of mission, number of crewmembers, number of Extravehicular Activities (EVAs), and anticipated level of care. The clinical priorities for all medical conditions on the Exploration Medical Condition List (EMCL) can be found here (https://humanresearchwiki.jsc.nasa.gov/index.php?title=Category:All_DRM). The EMCL document may be accessed here (https://humanresearchwiki.jsc.nasa.gov/images/6/62/EMCL_RevC_2013.pdf).

Design Reference Mission	Clinical Priority	Clinical Priority Rationale
Lunar sortie mission Assumptions: ▪ 4 crewmembers (3 males, 1 female) ▪ 14 days total ▪ 4 EVAs/crewmember ▪ Level of Care 3	Shall	The lunar sortie mission scenario involves several venues where pressure is expected to nominally change, for example, while conducting EVAs, with transfers between a pressurized habitat, a pressurized rover, and a pressurized EVA suit. Off-nominal contingencies may involve unintended pressure changes in any of the above situations, causing the development of altitude sickness. Therefore, treatment capability for altitude sickness shall be manifested.
Lunar outpost mission Assumptions: ▪ 4 crewmembers (3 males, 1 female) ▪ 180 days total ▪ 90 EVAs/crewmember ▪ Level of Care 4	Shall	The lunar outpost mission scenario involves several venues where pressure is expected to nominally change, for example, while conducting EVAs, with transfers between a pressurized habitat, a pressurized rover, and a pressurized EVA suit. Off-nominal contingencies may involve unintended pressure changes in any of the above situations, causing the development of altitude sickness. Therefore, treatment capability for altitude sickness shall be manifested.
Near-Earth Asteroid (NEA) mission Assumptions: ▪ 3 crewmembers (2 males, 1 female) ▪ 395 days total ▪ 30 EVAs/crewmember ▪ Level of Care 5	Shall	The atmospheric composition of the NEA transit vehicle is TBD. For lunar missions, a hypobaric and slightly hypoxic environment was contemplated, and, if a similar atmosphere is suggested for the NEA mission, this may increase the likelihood of encountering clinical altitude sickness. In addition, a NEA mission will involve venues where the ambient pressure is expected to decrease nominally (namely EVAs) as well as potential off-nominal contingencies where unintended pressure changes may occur (for example, compromise of vehicle integrity due to collision with debris). Therefore, due to the unknowns at this point in time, treatment capability for altitude sickness shall be manifested.

Initial Treatment Steps During Space Flight

A link is provided to a prior version of the International Space Station (ISS) Medical Checklist, which outlines the initial diagnostic and treatment steps recommended during space flight for various conditions which may be encountered onboard the ISS. Further diagnostic and treatment procedures beyond the initial steps outlined in the Medical Checklist are then recommended by the ground-based Flight Surgeon, depending on the clinical scenario. Please note that this version does not represent current diagnostic or treatment capabilities available on the ISS. While more recent versions of this document are not accessible to the general public, the provided version of the checklist can still provide a general sense of how medical conditions are handled in the space flight environment. Medical Checklists will be developed for exploration missions at a later point in time.

Please note this file is over 20 megabytes (MB) in size, and may take a few minutes to fully download.

ISS Medical Checklist (http://www.nasa.gov/centers/johnson/pdf/163533main_ISS_Med_CL.pdf)

Capabilities Needed for Diagnosis

The following is a hypothetical list of capabilities that would be helpful in diagnosis. It does not necessarily represent the current capabilities available onboard current spacecraft or on the ISS, and may include capabilities that are not yet feasible in the space flight environment.

- Pulse Oximeter
- Ausculation device (such as a stethoscope)
- Ophthalmoscope
- Imaging [Magnetic Resonance Imaging (MRI) or X-ray]

Capabilities Needed for Treatment

The following is a hypothetical list of capabilities that would be helpful in treatment. It does not necessarily represent the current capabilities available onboard current spacecraft or on the ISS, and may include capabilities that are not yet feasible in the space flight environment.

- Acetazolamide (oral)
- Nifedipine (oral)
- Steroids (oral and injectable)
- Intravenous (IV) start and administration kit
- Intravascular volume replacement (such as IV fluids)
- Supplemental oxygen
- Hyperbaric chamber (such as a Gamov bag). During an exploration mission, pressurizing the EVA suit for treatment (as is the current treatment plan on the ISS) may not be an ideal solution, as that would make the suit non-usable for further EVAs.

Associated Gap Reports

The NASA Human Research Program (HRP) identifies gaps in knowledge about the health risks associated with human space travel and the ability to mitigate such risks. The overall objective is to identify gaps critical to human space missions and close them through research and development. The gap reports that are applicable to this medical condition are listed below. A link to all of the HRP gaps can be found here (http://humanresearchroadmap.nasa.gov/Gaps/).

2.01 - We do not know the quantified health and mission outcomes due to medical events during exploration missions.
2.02 - We do not know how the inclusion of a physician crew medical officer quantitatively impacts clinical outcomes during exploration missions.
3.01 - We do not know the optimal training methods for in-flight medical conditions identified on the Exploration Medical Condition List taking into account the crew medical officer's clinical background. (Closed)
3.03 - We do not know which emerging technologies are suitable for in-flight screening, diagnosis, and treatment during exploration missions.
4.01 - We do not have the capability to provide a guided medical procedure system that integrates with the medical system during exploration missions.
4.02 - We do not have the capability to provide non-invasive medical imaging during exploration missions.
4.04 - We do not have the capability to deliver supplemental oxygen to crew members while minimizing local and cabin oxygen build-up during exploration missions.
4.05 - We do not have the capability to measure laboratory analytes in a minimally invasive manner during exploration missions.
4.09 - We do not have the capability to provide medical suction and fluid containment during exploration missions.
4.12 - We do not have the capability to generate and utilize sterile intravenous fluid from potable water during exploration missions.
4.14 - We do not have the capability to track medical inventory in a manner that integrates securely with the medical system during exploration missions.
4.15 - Lack of medication usage tracking system that includes automatic time stamping and crew identification
4.17 - We do not have the capability to package medications to preserve stability and shelf-life during exploration missions.
4.18 - Limited biomedical monitoring capability for exploration extravehicular activity suits (Gap merged with 4.19)
4.19 - We do not have the capability to monitor physiological parameters in a minimally invasive manner during exploration missions.
4.23 - We do not have the capability to auscultate, transmit, and record body sounds during exploration missions.
4.24 - Lack of knowledge regarding the treatment of conditions on the Space Medicine Exploration Medical Condition List in remote, resource poor environments (Closed)
4.25 - We do not have the capability to deliver injectable medication to a suited crewmember during exploration missions. (Gap on hold)
5.01 - We do not have the capability to comprehensively manage medical data during exploration missions.

Other Pertinent Documents

List of Acronyms

A	
AMS	Acute Mountain Sickness
D	
DRM	Design Reference Mission
E	
EMCL	Exploration Medical Condition List
EVA	Extravehicular Activity
H	
HAPE	High Altitude Pulmonary Edema
HACE	High Altitude Cerebral Edema
HARH	High Altitude Retinal Hemorrhage
HRP	Human Research Program
I	
ISS	International Space Station
IV	Intravenous
M	
MB	Megabyte
MRI	Magnetic Resonance Imaging
N	
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
NEA	Near Earth Asteroid
T	
TBD	To Be Determined

References

1. Bacal K, Beck G, Barratt MR. Hypoxia, Hypercarbia, and Atmospheric Control. In: Barratt M, Pool S, editors. Principles of Clinical Medicine for Space Flight. New York: Springer; 2008. p. 445-73.
2. Luks AM, McIntosh SE, Grissom CK, Auerbach PS, Rodway GW, Schoene RB, et al. Wilderness Medical Society consensus guidelines for the prevention and treatment of acute altitude illness. Wilderness Environ Med 2010 Jun;21(2):146-55.
3. Clark J. Decompression Related Disorders Pressurization Systems, Barotrauma, and Altitude Sickness. In: Barratt M, Pool S, editors. Principles of Clinical Medicine for Space Flight. New York: Springer; 2008. p. 247-71.

Last Update

This topic was last updated on 8/12/2014 (Version 2).

Retrieved from "https://humanresearchwiki.jsc.nasa.gov/index.php?title=Altitude_Sickness&oldid=5624"

Category: Medical Conditions

- This page was last modified on 12 August 2014, at 14:28.